

FINAL - ER 47 – Electrician Regulations Answer Schedule

Notes: 1. (1 mark) means that the preceding statement/answer earns 1 mark.

2. - This schedule sets out the expected answers to the examination questions. The marker can exercise their discretion and decide on the overall accuracy of any answer that is presented in the candidate's own words.

3. - Symbols and terms - alternatives -
 Power W or P -
 Voltage V or E or U -
 Phase Active -

Question 1	Marks	Reference	Marking notes
(a) • A person undergoing instruction or training for the purpose of obtaining registration as a registered person.	(1 mark)	EA 77(2)(a)	
• An apprentice who is working in the electricity industry.	(1 mark)	EA 77(2)(b)	
(b) Any TWO of: • Cancel the registration • Suspend the registration • Restrict the registration • Disqualify the person from doing prescribed electrical work • Impose a fine up to \$10,000 • Censure • Make no order	(2 marks)	EA 147M	
(c) • Minimum voltage 216.2V	(1 mark)	ESR 28(1)	
• Maximum voltage 243.8V	(1 mark)	ESR 28(1)	
(d) • The appliance is a fixed wired appliance connected through a continuous flexible cord to a supply of electricity from a source isolated from earth with a voltage between conductors not exceeding 250V AC volts.	(2 marks)	ESR 89(1)	
• The appliance is double insulated and is supplied with electricity through an RCD that provides protection against electric shock			
(e) • Any ONE of: * As for Type AC RCD * Residual sinusoidal alternating currents	(1 mark)	AS/NZS 3000: 2.6.2.2 Note 2(b)	

Question 1	Marks	Reference	Marking notes
Residual pulsating direct currents	(1 mark)	AS/NZS 3000: 2.6.2.2 Note 2(b)	
(f) Any TWO of: - The total of the connected load through the circuit - The maximum demand of the circuit. - The current rating of the circuit protective device - For final subcircuits with the load distributed over the whole of the length of the circuit, half the value of the protective device may be used as the value of current.	(2 marks)	AS/NZS 3000: 3.6.2(a) AS/NZS 3000: 3.6.2(b) AS/NZS 3000: 3.6.2(c) AS/NZS 3000: 3.6.2 Exception 1	
(g) Any TWO of: - Provided with adequate mechanical protection to prevent damage. - Provided with an earthed metallic covering or enclosure. - Protected by an RCD with a maximum rated operating current of 30 mA.	(2 marks)	AS/NZS 3000: 3.9.4.4	
(h) (i) 4 mm² - Copper (Cu)	(½ mark) (½ mark)	AS/NZS 3000 5.3.3.2	
(ii) 4 mm ²	(1 mark)	AS/NZS 3000 5.6.3.2(a)	
(i) (i) 16 amps	(1 mark)	AS/NZS 3000 Table 8.1	
(ii) 20 amps	(1 mark)	AS/NZS 3000 Table 8.1	

Question 1	<i>Marks</i>	<i>Reference</i>	<i>Marking notes</i>
(j) Precautions shall be taken to ensure the safety of persons and to avoid damage to property and the electrical installation equipment during inspection and testing.	(2 marks)	AS/NZS 3000: 1.8 8.1.2	

Question 2	Marks	Reference	Marking notes
(a) Any TWO of: - No shock hazard arises from the incorrect connection of active, neutral and earthing conductors - The transposition of active and neutral conductors of the consumers mains or submains having an MEN connection resulting in the electrical installation earthing system becoming energized - Combinations of incorrect active, neutral and earthing conductor connections resulting in the exposed conductive parts of the electrical installation becoming energized - Connection of switches in neutral conductors, resulting in parts of appliances, such as heating elements and lampholders, remaining energized when the switches are in the 'OFF' position.	(2 marks)	AS/NZS 3000 8.3.7.1	
(b) - Voltage tester - Temporary earth - Trailing lead	(3 marks)	GK	The term "trailing lead" can include the temporary earth
(c) - Install the remote earth and connect the trailing lead to it - Take a voltage test between the supply side of the main switch and the remote (or temporary or independent) earth. - Take a voltage test between the earth/neutral bar and the remote (or temporary or independent) earth.	(1 mark) (1 mark) (1 mark)	GK GK GK	1. The removal of the MEN link with the installation live is hazardous - no marks for (c) and (d) 2. The test on the phase can be taken at any open point upstream of the main switch
(d) (i) - The reading at the main switch should be 230V - The reading at the neutral/earth bar should be about 0V	(½ mark) (½ mark)	GK GK	

Question 2	Marks	Reference	Marking notes
(ii) • The reading at the main switch should be about 0V	(½ mark)	GK	
• The reading at the neutral/earth bar should be about 230V,	(½ mark)	GK	

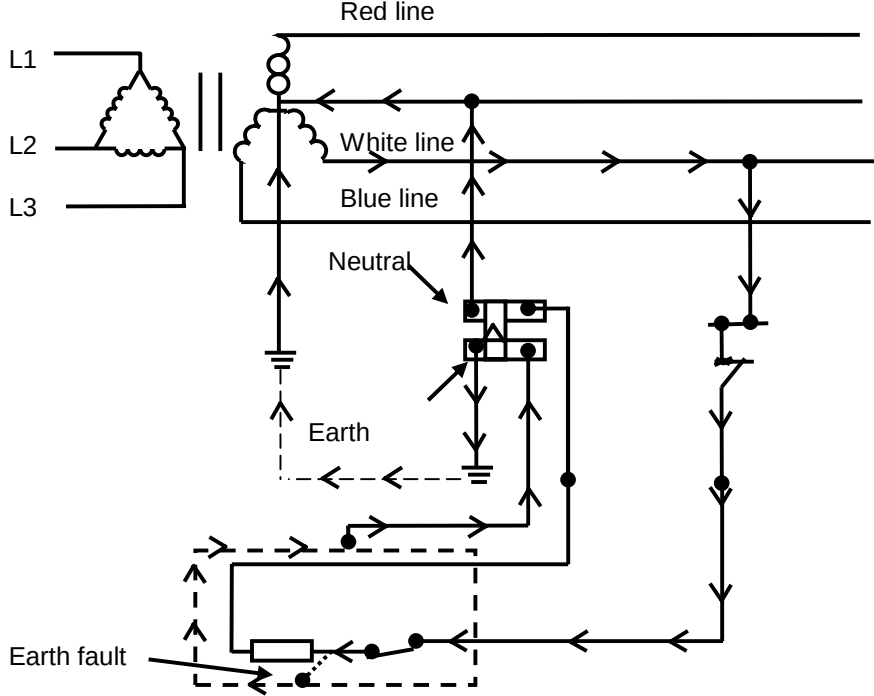
Question 3	Marks	Reference	Marking notes
(a) (i) Any TWO of: - The low voltage cables shall be of a type providing the equivalent of double insulation - All cables shall be insulated for the highest voltage present. - The low voltage cables shall be installed in a separate compartment having fixed and continuous barriers between compartments	(2 marks)	AS/NZS 3000 3.9.8.3	
(ii) Any ONE of: - Separation is required to ensure that faults occurring on the low voltage system are not transferred into the extra-low voltage system - To avoid any detrimental effects arising between circuits of an electrical installation operating at different voltages.	(2 marks)	GK AS/NZS 3000: 3.9.8.1(c)	The answer has to come from the preamble and part (c)
(b) • Be placed not more than 75mm above the wiring system; and • Be not less than 150mm wide; and • Overlap the wiring system by at least 40mm on each side; and • Any ONE of:	(½ mark) (½ mark) (½ mark) (½ mark)	AS/NZS 3000: 3.11.4.3(a) AS/NZS 3000: 3.11.4.3(b) AS/NZS 3000: 3.11.4.3(c) AS/NZS 3000: 3.11.4.3(d) (i) to (vii)	

Question 3	Marks	Reference	Marking notes
* Precast concrete slabs having a thickness of not less than 40 mm and a classification of not less than grade 20 in accordance with AS 3600 or NZS 3102. * Concrete slabs cast on site having a thickness of not less than 100 mm. * A continuous concrete pour having a thickness of not less than 75 mm. * Fibrous cement slabs having a thickness of not less than 12 mm. * Bricks manufactured specifically for the protection of electric cables. * Polymeric cable cover strip complying with AS 4702. * Other materials which offer the same degree of protection afforded by the materials above			
(c) • Of a type designed for such use. • Painted with light-coloured water-based acrylic paint	(1 mark) (1 mark)	AS/NZS 3000 3.10.3.7(a) AS/NZS 3000 3.10.3.7(b)	
(d) Any TWO of: • Covers shall be able to be opened, where practicable. • Covers shall be continuous when passing through walls or floors. • Cable trunking shall be accessible through its entire length. • Cables installed in a trunking shall not rely on any readily removable cover for support. • Non-hygroscopic trunking shall be used to enclose insulated cables (without sheath). • Live parts of accessories mounted on cable trunking shall be arranged so that basic protection is provided	(2 marks)	AS/NZS 3000 3.10.3.9	

Question 4	Marks	Reference	Marking notes
(a) • Part 2 • AS/NZS 3000	(½ mark) (½ mark)	ESR 60(1) ESR 60(1)	
(b) (i) AS/NZS 3000 (ii) Section 8	(½ mark) (½ mark)	ESR 65(1) GK	
(c) A certificate of compliance (or CoC)	(1 mark)	GK ESR 68(1)	
(d) (i) Mains work (ii) Any ONE of: • * Mains • * MEN switchboards closest to the point of supply • * The main earthing system or • * Work on mains • * Work on the main earthing system • * Work on the connection between earth and neutral made by the removable link within the MEN switchboard closest to the point of supply	(½ mark) (1½ marks)	ESR 70(1)(c) ESR 4 ESR 4 Amendment 1	
(e) Any FIVE of: • Ensure that the polarity of the supply is correct • Ensure that the protection of the supply is correctly rated • Ensure that the installation is compatible with the supply system. • Verify that there is a main earthing system	(5 marks)	ESR 73(2)(a)(i) ESR 73(2)(a)(ii) ESR 73(2)(a)(iii) ESR 73(2)(a)(iv)	

Question 5	<i>Marks</i>	<i>Reference</i>	<i>Marking notes</i>
(a) Any FOUR of: • A touch voltage hazard between conductive parts and the mass of earth. • Protective devices may not operate under fault conditions due to reduced fault current. • Fire hazard at any high resistance joint in the main neutral. • Fire hazard because the main earthing conductor is carrying a higher current than it can safely carry continuously. • Over or under voltage could damage equipment – particularly on three phase installations.	(4 marks)	Gk	
(b) Any TWO of: • A cooking appliance shall be provided with a switch, operating in all active conductors, mounted near the appliance in a visible and readily accessible position. • The switch should be mounted within 2 m of the cooking appliance. • But not on the cooking appliance in such a position that the user does not have to reach across the open cooking surface.	(2 marks)	AS/NZS 3000 4.7.1 AS/NZS 3000 4.7.1: Note 1 AS/NZS 3000 4.7.1: Note 1	

Question 5	Marks	Reference	Marking notes
(c) Any TWO of: - Where installed in a floor or other horizontal surface, socket-outlets shall be arranged or of such design that dust or water cannot accumulate therein. - Where installed within 75 mm of a floor, socket-outlets shall be installed so that any plug used with the socket-outlet is withdrawn in the horizontal plane or complies with Item (a). - Socket-outlets shall be so installed that a plug is not likely to become loose or malfunction due to gravity, vibration or the weight of the flexible cord or cable. - Where installed for the connection of a fixed or stationary appliance or a luminaire that is not readily accessible, the socket outlet shall be securely fixed to a structure or support. - The use of socket outlet is restricted in a number of particular locations, including damp situations. - Where socket outlets are installed in building surfaces that are required to provide fire-resistance or acoustic properties, measures shall be taken to ensure these properties are maintained.	(2 marks)	AS/NZS 3000: 4.4.2.2	
(d) Any TWO of - The gM fuse links will withstand motor starting currents. - Starting currents up to 7 times full load current. - The fusing factor (utilisation category) is typically between 1.6 and 2.5	(2 marks)	Gk	

Question 6	Marks	Reference	Marking notes
(a)  (i) - • MEN system - Star point earthed. (½ mark) - The consumer's main earth connected to the earth bar. (½ mark) - MEN link between earth and neutral bars. (½ mark) - Main neutral connected to consumer's neutral bar. (½ mark) • - Correct distribution system (1 mark) • - The final sub-circuit MCB in the phase (1 mark) (ii) - Accurate earth fault loop (1 mark)			
(b) Any ONE of: -	(1 mark)		

AS/NZS 3000
Figure B5

The path between the star-point and the installation earth need not be shown. The path via the neutral must be shown.
No marks awarded for (a) if:

- - star point not earthed
- - appliance not earthed
- - installation not earthed
- - no main neutral on the installation

Question 6	Marks	Reference	Marking notes
- The characteristics of protective devices and the earthing system impedance shall be such that, if a fault of negligible impedance occurs anywhere in the electrical installation between an active conductor and a protective earthing conductor or exposed conductive part, automatic disconnection of the supply will occur within the specified time. - The impedance of the earthing system shall be limited to that which will generate sufficient current in the protective device to cause the operation of that device within the required time. - In order to verify the complete faults loop, including the integrity of the MEN connection and the upstream neutral (PEN) conductors		AS/NZS 3000 1.5.5.3(c) 5.7.4 AS/NZS 3000 5.7.1 AS/NZS 3000 8.3.9.1	
(c) (i) 0.4 seconds	(1 mark)	AS/NZS 3000 1.5.5.3(d)	
(ii) 68 metres	(1 mark)	AS/NZS 3000 Table B1	
(d) • 50 V a.c.	(1 mark)	AS/NZS 3000 5.7.1	
• 120 V ripple-free d.c.	(1 mark)	AS/NZS 3000 5.7.1	

Question 7	Marks	Reference	Marking notes
(a) (i) Any TWO of: • Consumers mains • Where the neutral conductor is used as a combined protective earthing and neutral conductor. • An earth sheath return (ESR) system • A submain where the neutral is used for earthing of an electrical installation in an outbuilding	(2 marks)	AS/NZS 3000: 2.3.2.1.1 (b)(i)	
(ii) Any ONE of: • A single-phase appliance will not work, although the phase conductor remains live. • The potential across the frame of the appliance can rise to near 230V • In three-phase systems voltages across loads will decrease or increase • Protective devices may not operate because of the high impedance of the fault path through the mass of earth.	(2 marks)	GK	
(b) Any FOUR of: • Installed so as to prevent unintentional closure. • Shall be inserted in the main circuit • They need not interrupt all alive conductors • Provided with facilities for securing it in the open position • Shall be placed and marked so as to be readily identified a convenient for their intended use.	(2 marks)	AS/NZS 3000: 2.3.6.2(a) AS/NZS 3000: 2.3.6.3 AS/NZS 3000: 2.3.6.3 AS/NZS 3000: 2.3.6.3 AS/NZS 3000: 2.3.6.4	Any installation requirement for a switching device suited to mechanical maintenance is acceptable
(c) Any FOUR of:	(2 marks)		

Question 7	<i>Marks</i>	<i>Reference</i>	<i>Marking notes</i>
• Shall be capable of withstanding an impulse voltage likely to occur at the point of installation, or shall have an appropriate contact gap. • Shall not be able to falsely indicate that the contacts are open. • Shall clearly and reliably indicate the isolating position of the device • Designed so as to prevent unintentional closure. • Shall disconnect all active conductors of the relevant supply. • If it is a switching device, shall be capable of being locked in the open position.		AS/NZS 3000: 2.3.2.2.1(a) AS/NZS 3000: 2.3.2.2.1(b) AS/NZS 3000: 2.3.2.2.1(c) AS/NZS 3000: 2.3.2.2.1(d) AS/NZS 3000: 2.3.2.2.1 AS/NZS 3000: 2.3.2.2.1	
(d) Any ONE of: • Shall be not more than one main switch for each separately metered supply. • Where there is more than one separately controlled supply from a meter, a main switch for each of the separately controlled supply	(2 marks)	AS/NZS 3000: 2.3.3.2	

Question 8	<i>Marks</i>	<i>Reference</i>	<i>Marking notes</i>
(a) Any ONE of: • The highest expected loading of an installation under foreseeable conditions • Shall be determined taking into account the capacity, physical distribution and intended use of electrical equipment in the electrical installation and the manner in which the present requirements may vary.	(2 marks)	GK AS/NZS 3000 1.6.3	

(b)

Solution 1

Equipment	Load Group	Calculation	Load (Amps)	
25 - lighting points	A(i)	3 + 2	7	(1 mark)
10 metres of lighting track		2		
10 - 150W outside lights	A(ii)	$(1500 \div 230) \times 0.75$	4.89	(1 mark)
18 - double socket outlets (10 A)	B(i)	36 points	20	(1 mark)
10 - single socket outlets (10 A)		10 points		
1 - 3 kW controlled water heater	F	$3000 \div 230$	13.04	(1 mark)
1 - electric range (6 kW)	C	$(6000 \div 230) \times 0.5$	13.04	(1 mark)
2 - 15A space heaters	D	30×0.75	22.5	(1 mark)
1 - 4 kW air conditioner unit	D	$(4000 \div 230) \times 0.75$	13.04	(1 mark)
Maximum demand			93.51A	(1 mark)

A total between 90A and 96A is acceptable.

AS/NZS 3000: Table C1

Solution 2

Equipment	Load Group	Calculation	Load (Amps)	
25 - lighting points	A(i)	3 + 2	7	(1 mark)
10 metres of lighting track		2		
10 - 150W outside lights	A(ii)	$(1500 \div 230) \times 0.75$	4.89	(1 mark)
18 - double socket outlets (10 A)	B(i)	36 points	20	(1 mark)
10 - single socket outlets (10 A)		10 points		
1 - 3 kW controlled water heater	F	$3000 \div 230$	13.04	(1 mark)
1 - electric range (6 kW)	C	$(6000 \div 230) \times 0.5$	13.04	(1 mark)
2 - 15A space heaters	D	30×0.75	22.5	(1 mark)
1 - 4 kW air conditioner unit	D	$(4000 \div 230) \times 0.75 = 13.04A$ This load does not need to be included. See Note k to Table C1	0	(1 mark)
Maximum demand			80.47A	(1 mark)

A total between 77A and 83A is acceptable.

AS/NZS 3000: Table C1

Question 9	Marks	Reference	Marking notes
(a) Load growth = 85 + 20% = 102A From Column 5 Table 13 the rating for 25 mm² is 104A amps. From Table 27(1), the de-rating factor for 35°C is 0.94 The maximum load can be carried by the 25 mm² cable is: = 104 x 0.94 = 97.76A A 35mm² will satisfy the load requirements.	(½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (1 mark) (1 mark)		
(b) Maximum volt drop permitted = 400 x 1.5% = 6V $V_d = \frac{\text{mV/A.m} \times A \times m}{1000}$ $\text{mV/A.m} = \frac{V_d \times 1000}{A \times m}$ = $\frac{6 \text{ v} \times 1000}{102 \times 70}$ = 0.8403mV/A.m From Table 42 a 0.8403 mV/A.m equates to a 50 mm² cable A 50mm² will satisfy the voltage drop requirements.	(½ mark) (½ mark) (½ mark) (½ mark) (½ mark) (1 mark) (½ mark) (1 mark)		
(c) A 50mm² will satisfy the load and voltage drop requirements.	(½ mark)		